Wisdom is not the product of schooling but the lifelong attempt to acquire it.
- Albert Einstein

Meta-Design: Putting Owners of Problems in Charge

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Overview

- The Center for Lifelong Learning and Design (L3D)
- Core Message
- Design and Meta-Design
- Examples
  - Domain-Oriented Design Environments
  - Envisionment and Discovery Collaboratory
- Transforming Application Areas
- Research Challenges
- Conclusions

L^3D's Research Focus and Intellectual Identity

- **Artificial Intelligence (AI) → Intelligence Augmentation (IA)**
  - replacement → empowerment
  - emulate → complement (exploit unique properties of new media)

- **instructionist learning → constructionist learning**
  - learning about → learning to be
  - when the answer is known → when the answer is not known (collaborative knowledge construction)

- **individual → social (distributed intelligence, social creativity)**
  - knowledge in the head → knowledge in the world
  - access → informed participation
  - within cultures → across cultures

L³D's Research Focus and Intellectual Identity

- **design** → **meta-design**
  - reflective practitioners → reflective community
  - developers → all stakeholders
  - complete systems → seeds
- **generic** → **specific**
  - human-computer interaction → human problem domain interaction
  - general → customization, personalization
- **"gift-wrapping"** → **co-evolution**
  - knowledge in the head → distributed intelligence
- **desktop** → **ubiquitous computing**

Core Message

- **meta-design** (= design for designers) is **more than a technical problem**

- **meta-design** creates **new mindsets**, new **sources of creativity**, **culture changes**, and **innovative societies** by providing new insights into
  - learning and working
  - communicating
  - design and design communities
  - collaboration
  - co-creation

Cultures and Media

- **claim: cultures** are substantially defined by their media and tools for thinking, working, learning, and collaborating (most prominent example: oral → literal societies)

- **fundamental challenge for computational media:** to contribute to the invention and design of cultures in which humans can express themselves and engage in **personally meaningful activities**

- **new media change**
  - the tasks which humans do (→ new divisions of labor)
  - the structure and contents of our interests
  - the nature of our cognitive and collaborative tools
  - the social environment in which thoughts originate and evolve, and mindsets develop

- **empirical observation:** a large number of new media are designed from the perspective of seeing and treating humans primarily as **consumers**

Challenge: Creation of and Control over Digital Artifacts

- **interview with a geoscientist** (Institute of Arctic and Alpine Research at the University of Colorado):

  "I spend in average an hour every day developing software for myself to analyze the data I collected because there is not any available software.

  Even if there is a software developer sitting next to me, it would not be of much help because my needs vary as my research progresses and I cannot clearly explain what I want to do at any moment.

  Even if the software developer can mange to write a program for me, I will not know if he or she has done it right without looking at the code.

  So I spent three months to gain enough programming knowledge to get by. Software development has now become an essential task of my research, but I do not consider myself a software developer and I don't know many other things about software development."

Users, End-Users, Programmers

- **computer use at work in 1997**
  - 64 million Americans

- **estimate for 2012**
  - 90 million end users in American workplaces
  - 55 million will use spreadsheets or databases (and therefore may potentially program)
  - 13 million will describe themselves as programmers
  - fewer than 3 million professional programmers

- **source:**
  - Scaffidi, C., Shaw, M., & Myers, B. (2005) "Estimating the Numbers of End Users and End User Programmers." In Proceedings of 2005 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'05), Dallas, Texas, September, pp. 207-214.

Zeitgeist: Web 2.0

Meta-Design: A Conceptual Framework for Web 2.0

- **source:** Tim O'Reilly *"What is Web 2.0 — Design Patterns and Business Models for the Next Generation of Software"*

Web 1.0		**Web 2.0**
Britannica Online	→	Wikipedia
personal website	→	blogging
publishing	→	participation
content management systems	→	wikis
scheduled software releases	→	continuous improvements
individual contributions	→	collective intelligence

- **claim**: network effects from user contributions (= knowledge sharing) are the key to market dominance in the Web 2.0 era

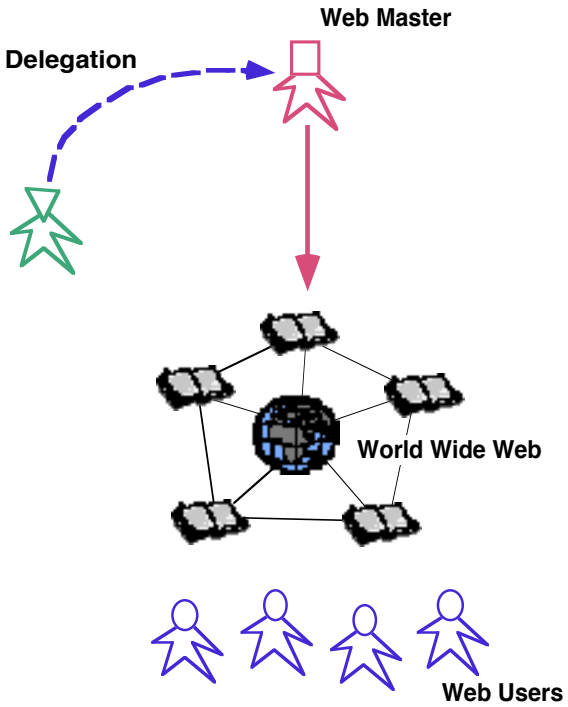
Web 2.0 — Putting Owners of Problems in Charge

- **Web 2.0**
  - enables interactive social computing applications
  - empowers everyone to become a designer/ publisher

- **claims:**
  - it no longer takes a team of programmers, graphic designers, and content authors to create a compelling web experience
  - Web services and related technologies allow owners of problems (with some digital literacy) to create new services out of existing ones (mash-ups) with a reasonable effort

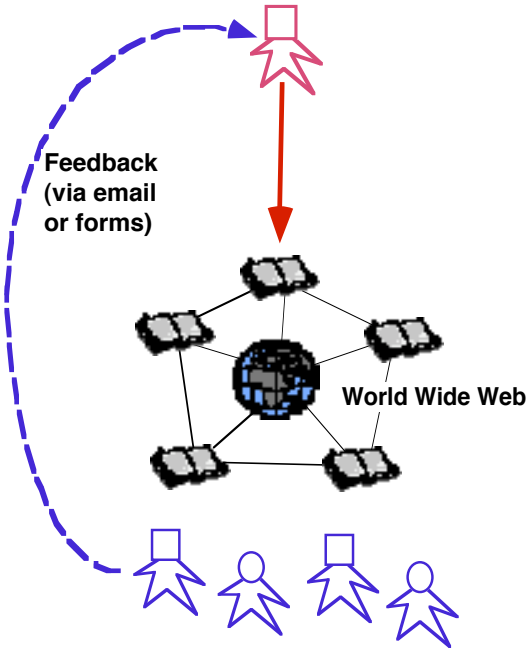
- **questions:**
  - What are the cultural implications as more and more people publish?
  - Is there a limit to how many people will publish?

WWW: From Broadcast to Collaboration Medium



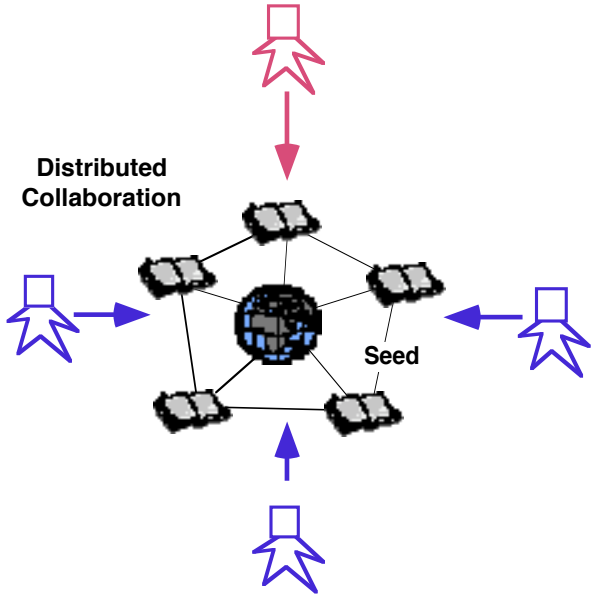
M1

The Web as Broadcast Medium



M2

Broadcast with Feedback



M3

Evolutionary and Collaborative Design

The "WE" in the Web

Design and Collaborative Design

- **design**
  - **natural science**: how things are
  - **design**: how things ought to be (Herbert Simon "Sciences of the Artificial")

- **design problems** are
  - **complex** → requiring **social creativity** in which stakeholders from different disciplines have to **collaborate**
  - **ill-defined / wicked** → requiring the **integration of problem framing and problem solving,** problems have **no stopping rule**
  - **have no (single) answer** → requiring **argumentation support**
  - **unique** ("a universe of one") → requiring **learning when the answer is not known**

Design: Beyond Binary Choices

- **Turing Tar Pit:** *"Beware of the Turing Tar Pit, in which everything is possible, but nothing of interest is easy."*
  - current interactive programming environments are sufficient for supporting meta-design because level of representation is still too far removed from the conceptual world of the domain workers
  - claim: do not focus on objective computability but on *subjective computability*

- **The Inverse of the Turing Tar Pit:** *"Beware of the over-specialized systems, where operations are easy, but little of interest is possible."*
  - domain-specific tools (such as SimCity) provide extensive support for certain problem contexts
  - the ability to extend these environments is limited — even minor incremental changes are often impossible in these systems

Meta-Design — How We Think About It

- "if you give a fish to a human, you will feed him for a day — if you give someone a fishing rod, you will feed him for life" (Chinese Proverb)

- **meta-design** extends this to:

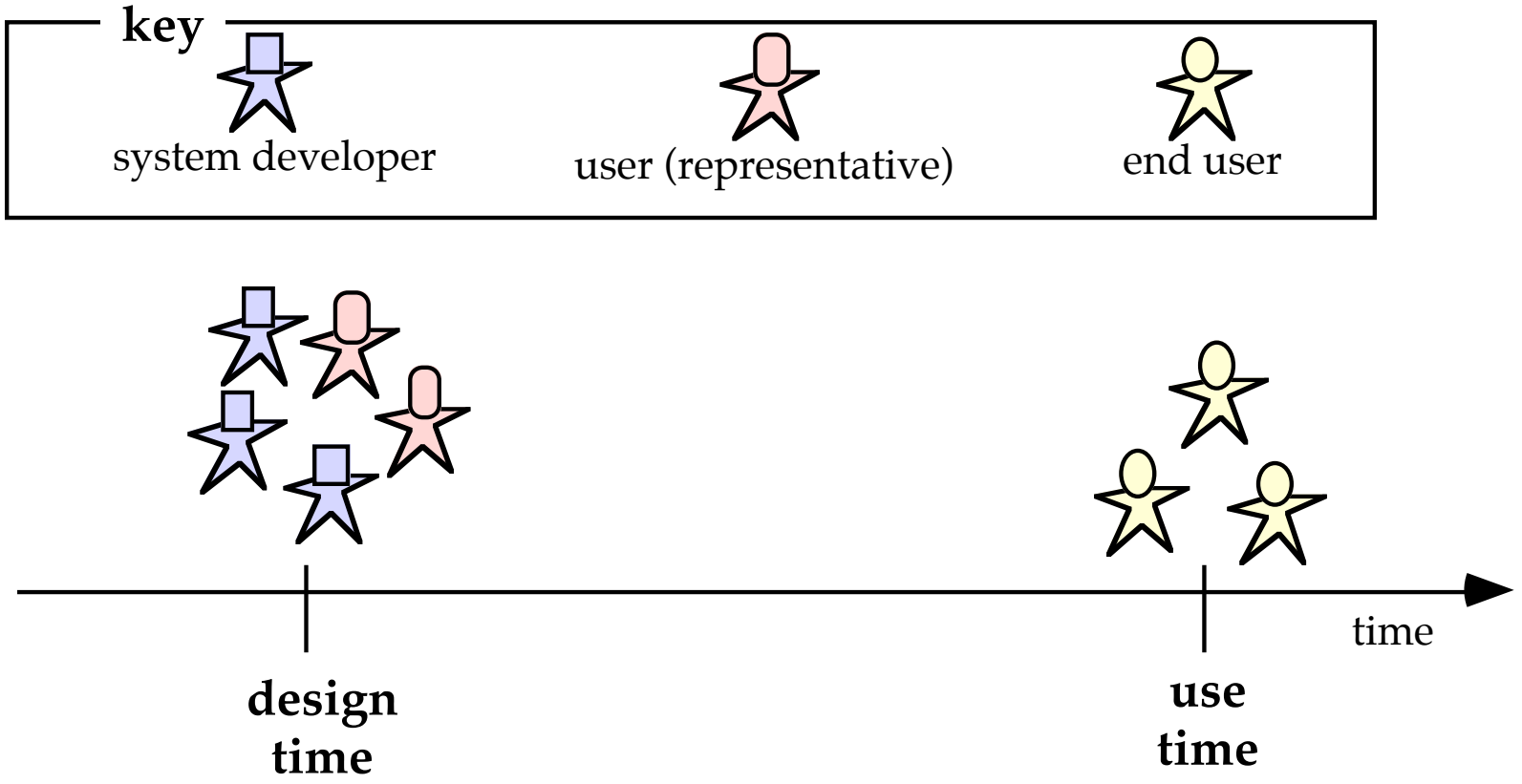
  "if we can provide the knowledge, the know-how, and the tools for making fishing rods, we can feed the whole community"

Meta-Design

- **meta-design**
  - new media that allow users to act as designers and be creative
  - the creation of context rather than content
  - puts the tools rather than the object of design in users' hands
  - does not define a product, but the conditions for a process of interaction

- **why meta-design?**
  - design for diversity (for "a universe of one" → CLever Project)
  - design as a process is tightly coupled to use and continues during the use of the system
  - addresses and can overcome problems of closed systems
  - prerequisite for social creativity and innovation
  - transcends a "consumer mindset"

Design Time and Use Time



world-as-imagined
prediction
planning

world-as-experienced
reality
situated action

Computational Media
—
Extending Design Opportunities at Use Time

- **print media:** a fixed context for use time is decided at design time

- **computational media**:
  - presentations at use time can take advantage of contextual factors only known at use time (about tasks, users, social systems,.....)
  - examples: specification sheets and usage data, supporting dynamic forms, dynamic websites, user and task specific maps and traffic schedules....

- **evolving existing systems**: users (acting as designers) can transcend at use time the boundaries of the systems as developed at design time

Meta-Design: Completing Other Design Methodologies

- **hardware oriented design**
  - humans have to adapt to the technology
- **professionally-dominated design**
  - works best for people with the same interests and background knowledge
- **user-centered design:**
  - analyze the needs of the users
  - understand the conceptual worlds of the users
- **participatory design**
  - involve users more deeply in the process as co-designers by empowering them to propose and generate design alternatives
  - focus on system development at design time by bringing developers and users together to envision the contexts of use

Meta-Design: Completing Other Design Methodologies

- **learner-centered design**
  - draws attention to the changing needs of users
  - combine HCI interaction principles with educational interaction support

- **meta-design:**
  - create design opportunities at use time
  - requires co-creation

What Do Meta-Designers Do?

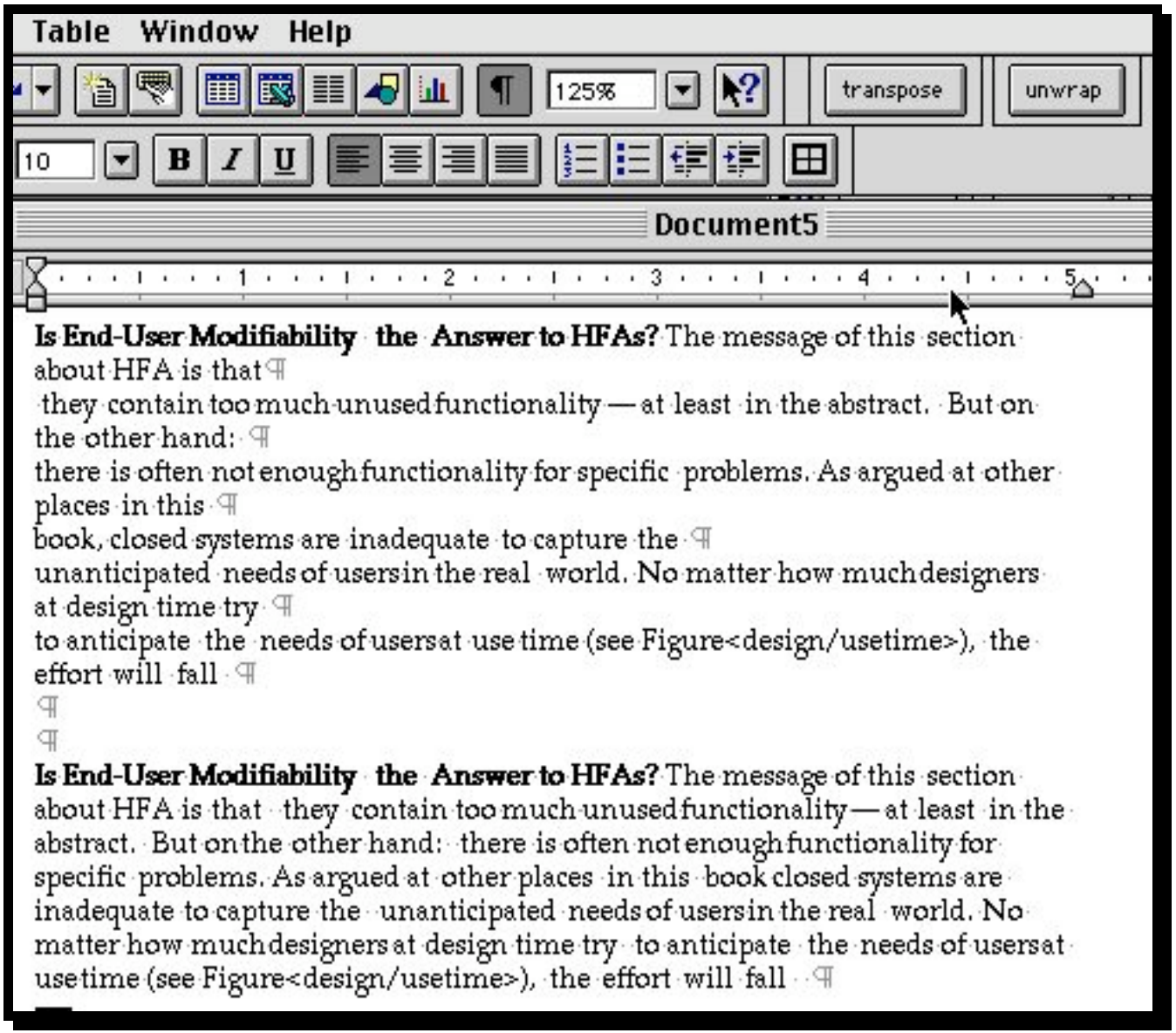
- use their own creativity to create socio-technical environments in which other people can be creative

- create the technical and social conditions for broad participation in design activities which are as important as creating the artifact itself

Meta-Design Concepts (in Microsoft Word)
—
Users as Co-Developers

- ***tailor*** and ***customize*** the system by setting different parameters as their personal preferences
- ***extend*** and ***evolve*** existing information structures (e.g., menus, spelling dictionaries, auto-correct tables, …)
- write ***macros*** to create new operations (an example of “programming by example” or “programming by demonstration”)
- create ***programs in VisualBasic*** to extend the functionality of the system
- ***share*** the user-defined extensions

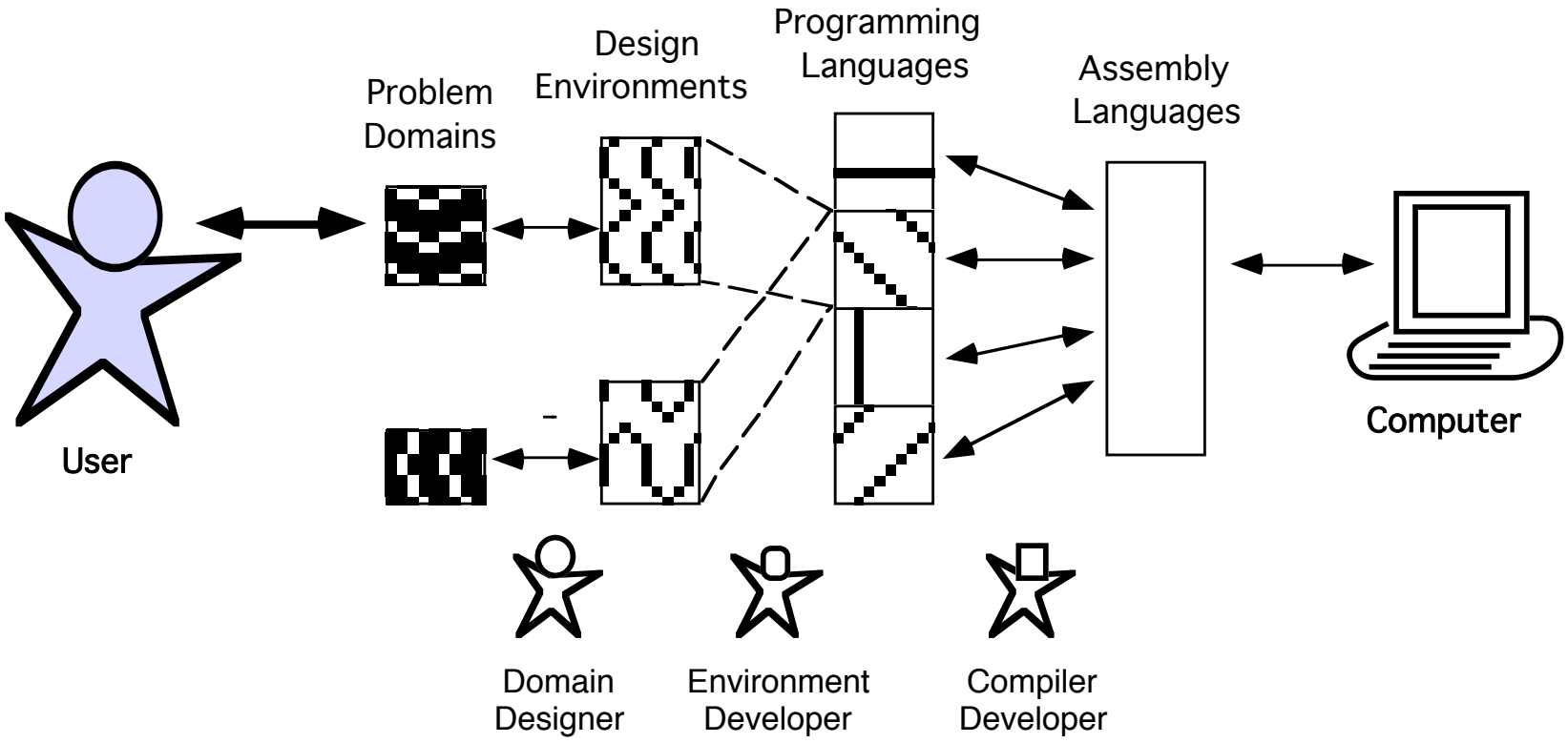
A Macro for Unwrapping Text



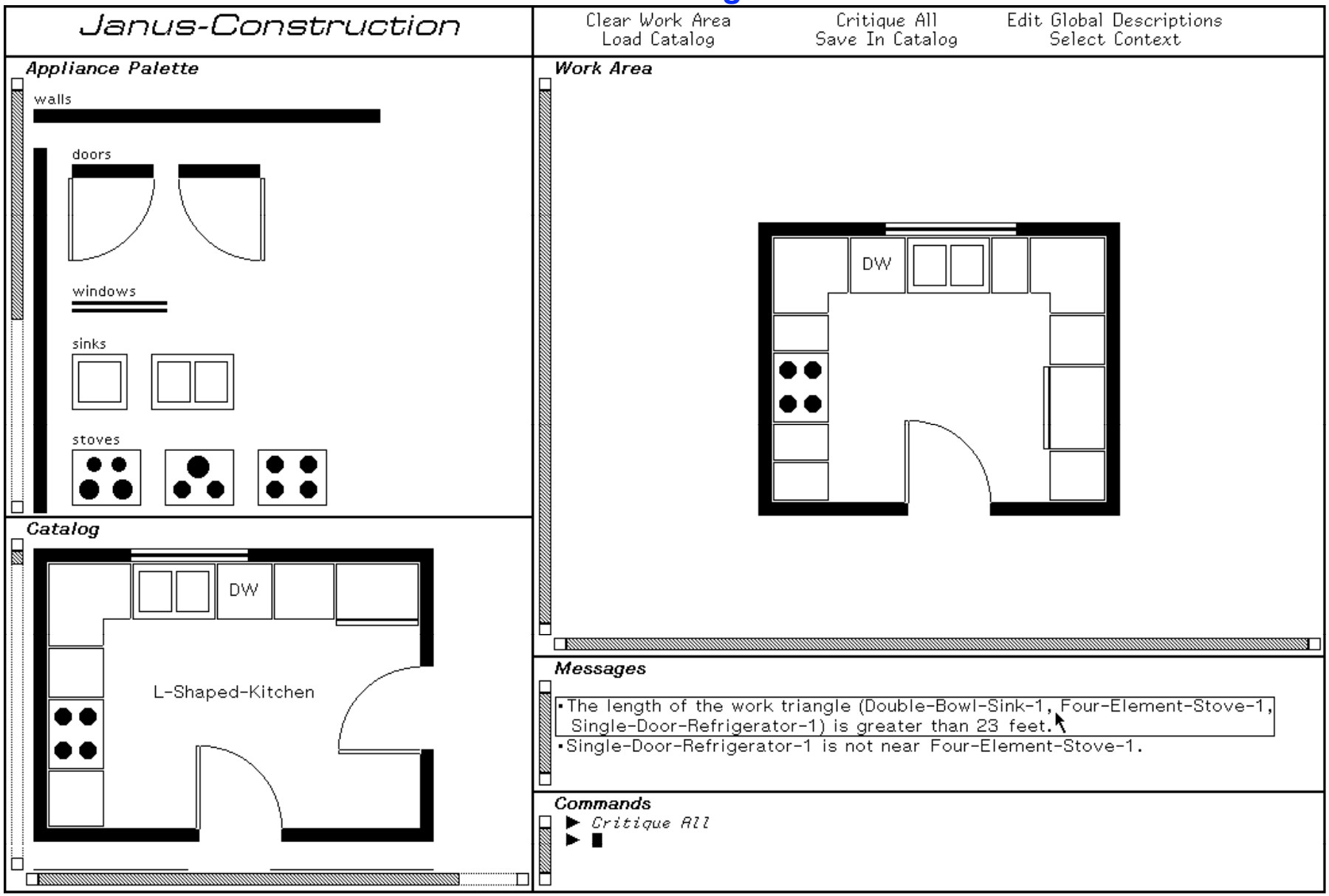
Example: Domain-Oriented Design Environments
—
Putting Owners of Problems in Charge

- human computer interaction → **human problem domain interaction**
- supporting reflective practitioners with **"reflection-in-action"** (Schön)
- based on a **layered architecture** to achieve external simplicity with internal complexity

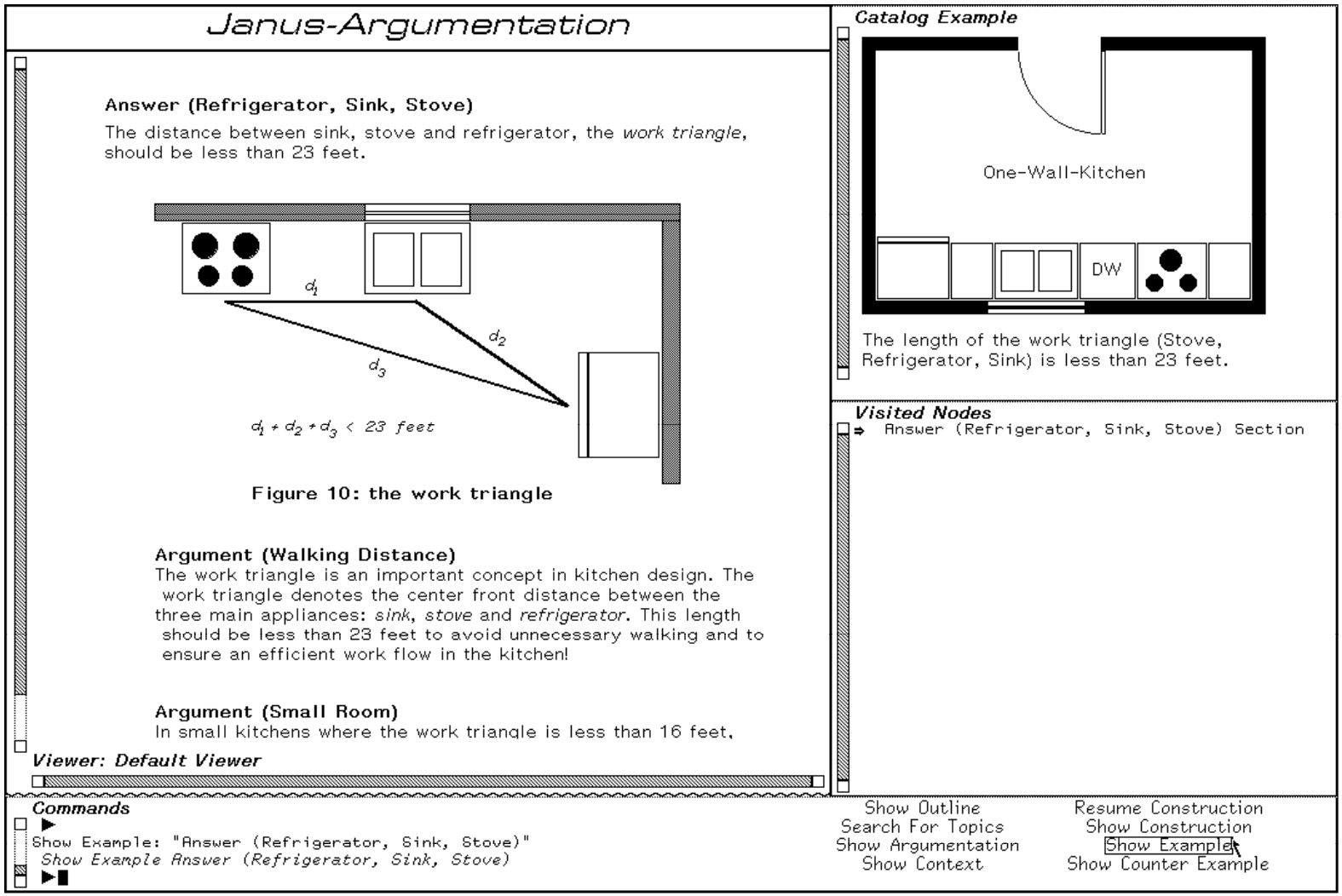
Layered Architectures in Support of Human Problem Domain Interaction



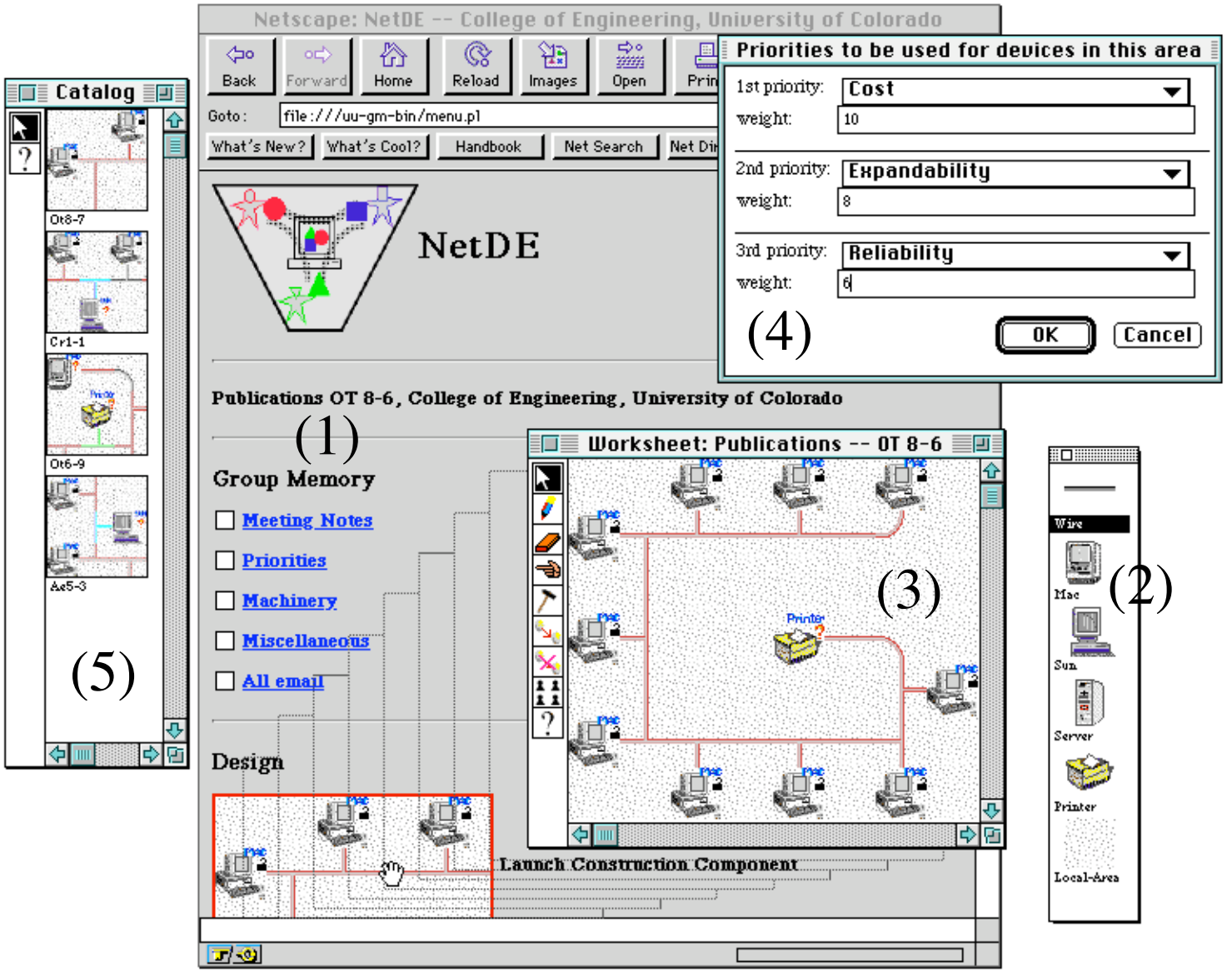
A DODE for Kitchen Design: Construction



A DODE for Kitchen Design: Argumentation

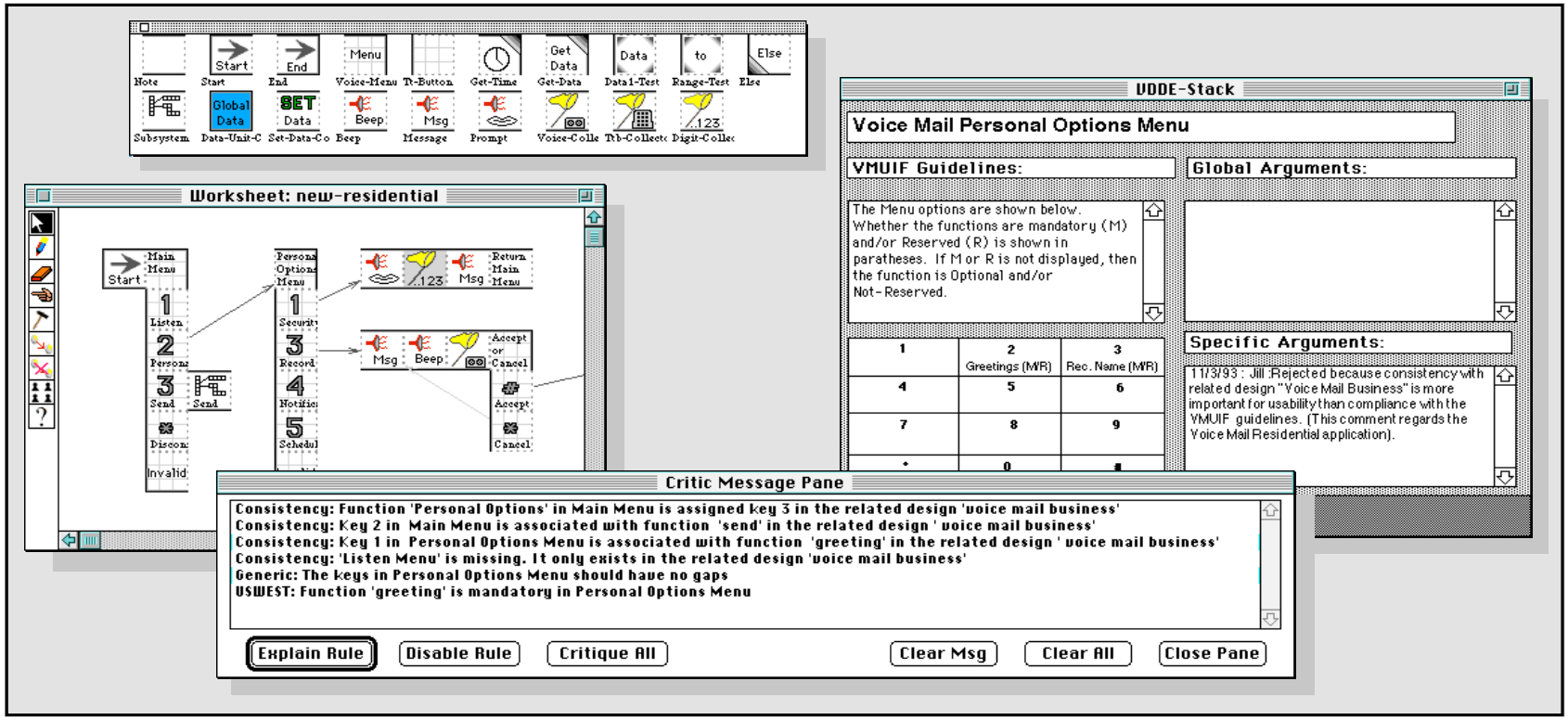


A DODE for Computer Network Design



VDDE: Voice Dialog Design Environment

a collaborative research project with USWest
(a major telecommunication company)



Example:
The Envisionment and Discovery Collaboratory (EDC)

- **creating shared understanding through collaborative design**
  - symmetry of ignorance, mutual competence, and breakdowns as sources of opportunity

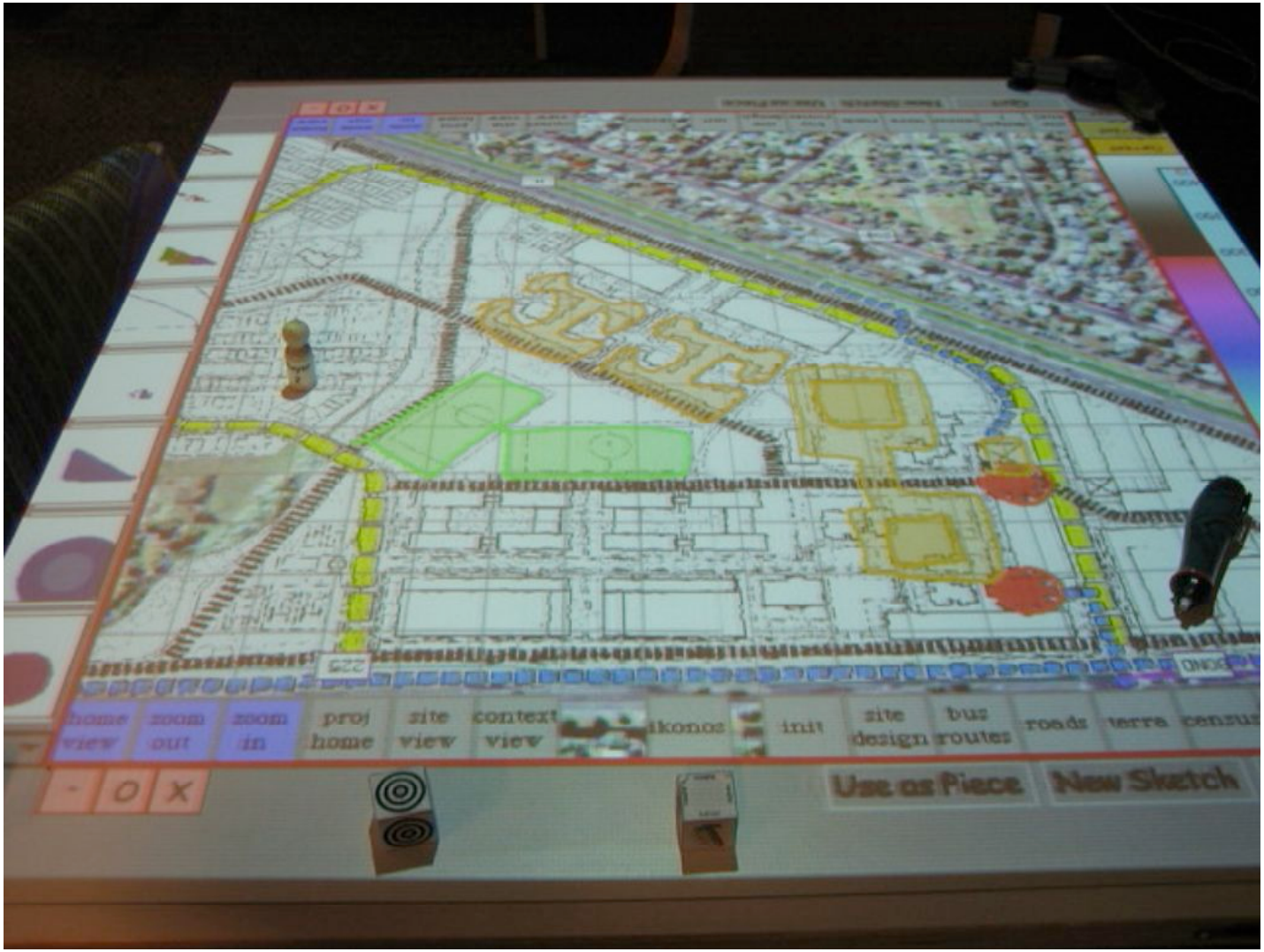
- **integration of physical and computational environments**
  - hardware: electronic whiteboards, crickets
  - software: Squeak
  - beyond the screen: immersive environments

- **support for:**
  - social creativity
  - meta-design and informed participation
  - collaborative design
  - reflection-in-action
  - reflective communities
  - boundary objects

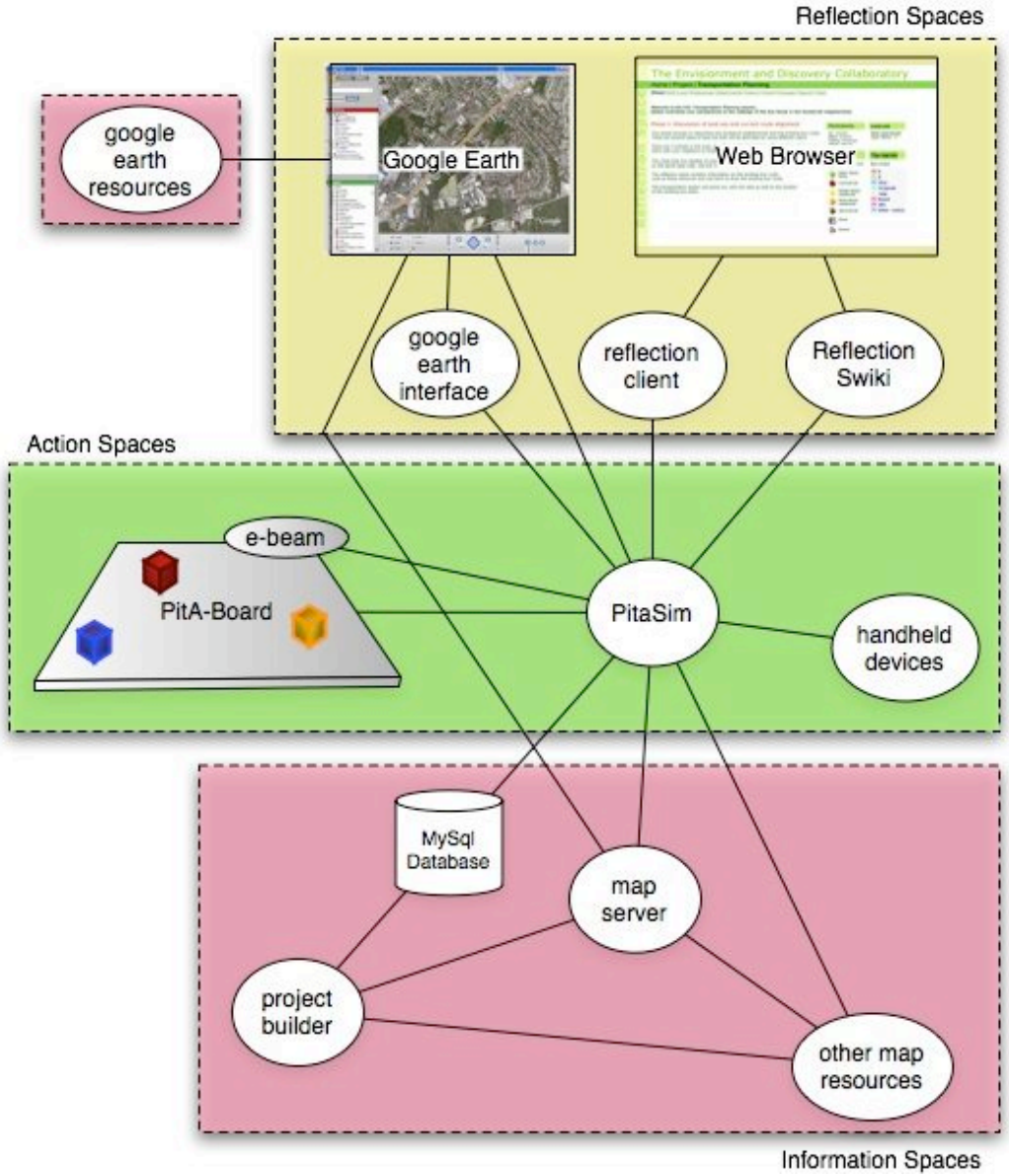
The Envisionment and Discovery Collaboratory (EDC)

Boulder City Council and University of Colorado Regents

Sketching Support in the EDC

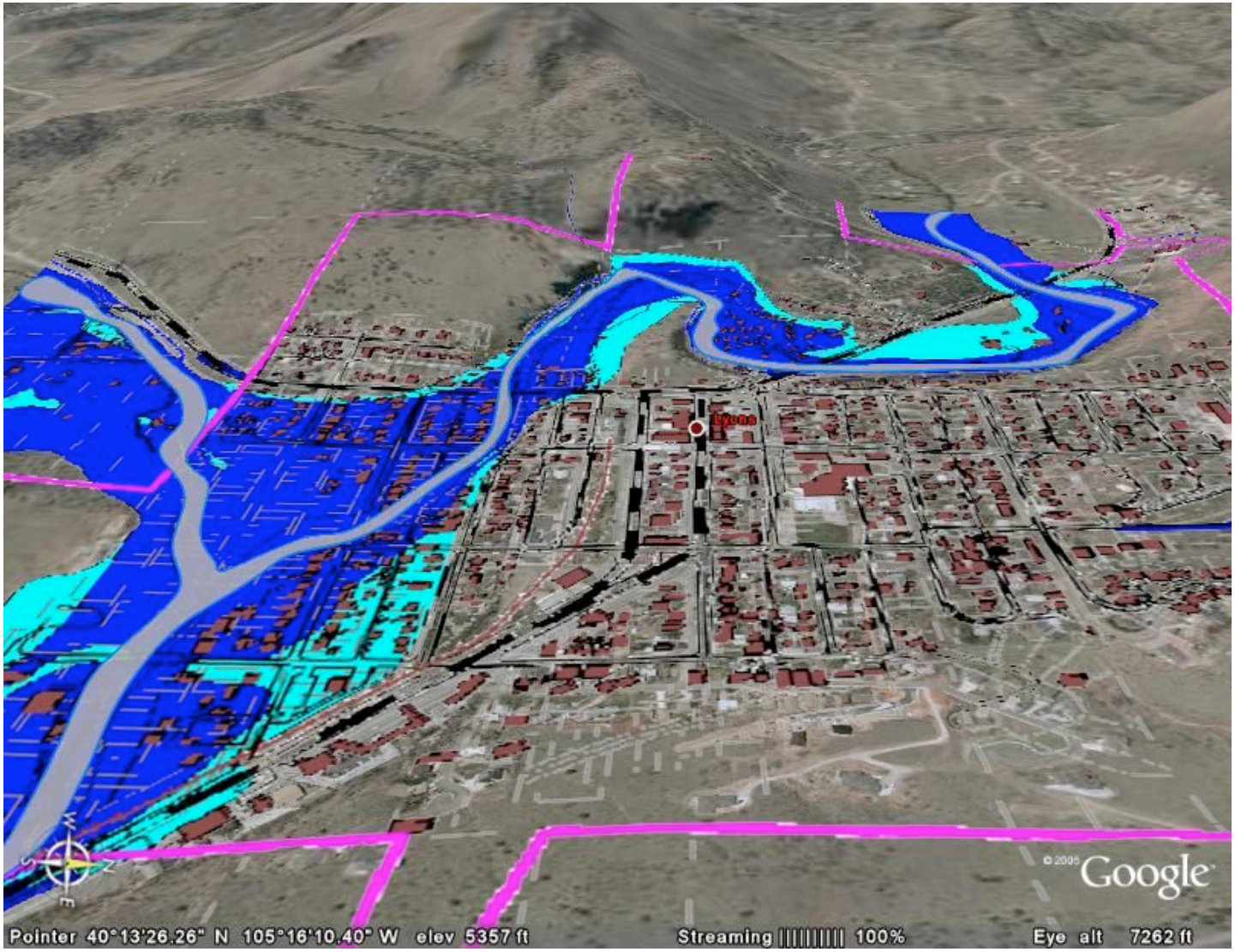


The Architecture of the EDC



Application Context — Emergency Management: Fires

Application Context —Emergency Management: Flooding

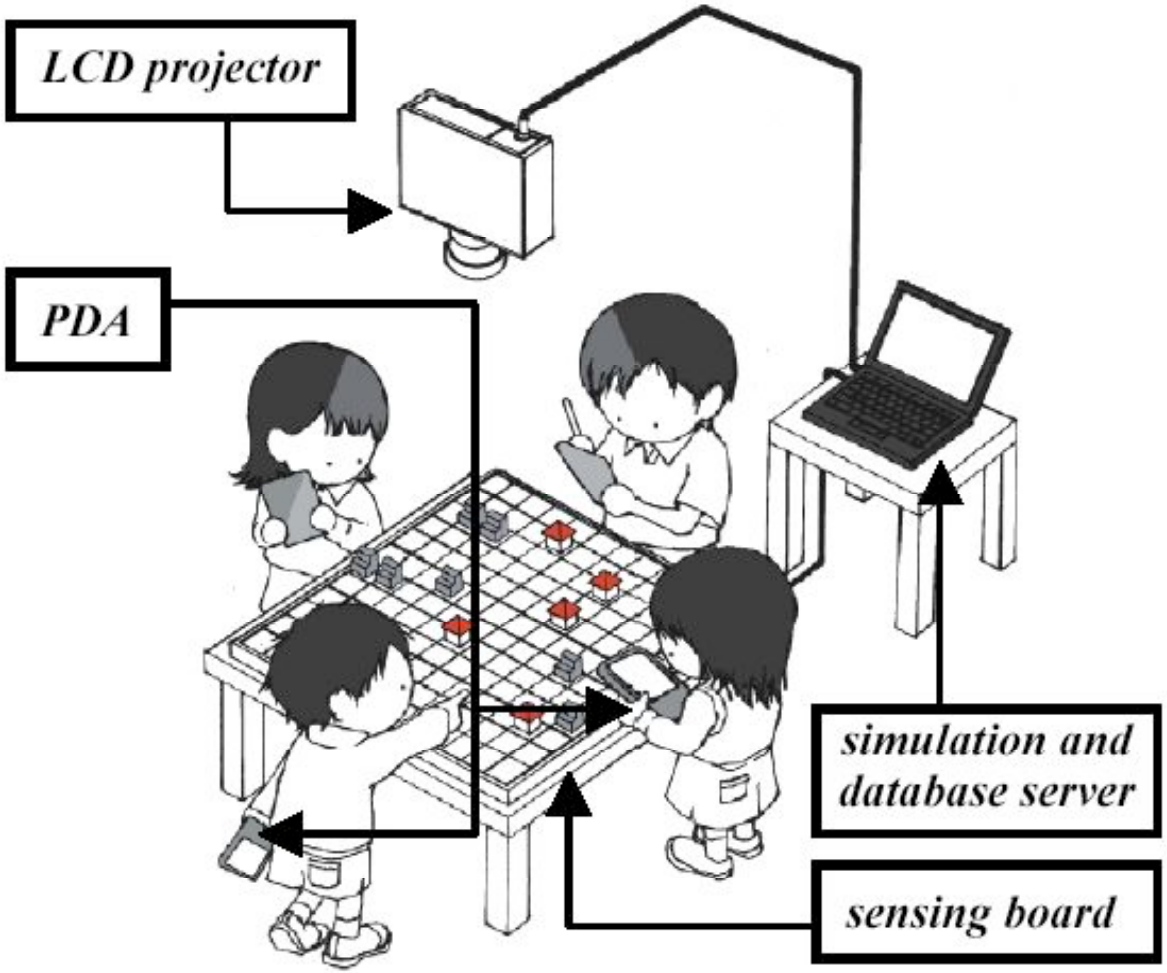


Buildings Sketched into a Google-Earth Client

Integrating Individual and Social Creativity

—

Caretta



New L3D Research Project (2006-2009), Science of Design Program, NSF-CISE

A Meta-Design Framework for Participative Software Systems

- *participative software systems*: achieving the best fit between the software system and its ever-changing context of use, problems, domains, users, and communities of users

- define the scientific foundation for designing participative software systems as socio-technical environments that empower users, as *owners of problems*, to engage actively and collaboratively in the *continual development* of software systems

- develop a *meta-design framework* to guide software developers to design participative software systems

- meta-designed systems can be supported by the *Seeding, Evolutionary Growth, and Reseeding (SER) process model*

Meta-Design Aspects in the EDC: Closed versus Open Systems

- **example for a closed system: SimCity —** too much crime
  - solution supported: build more police stations (**fight crime**)
  - solution not supported: increase social services, improve education (**prevent crime**)

- **important goal of EDC:** create end-user modifiable versions of SimCity, because:
  - background knowledge can never be completely articulated
  - the world changes

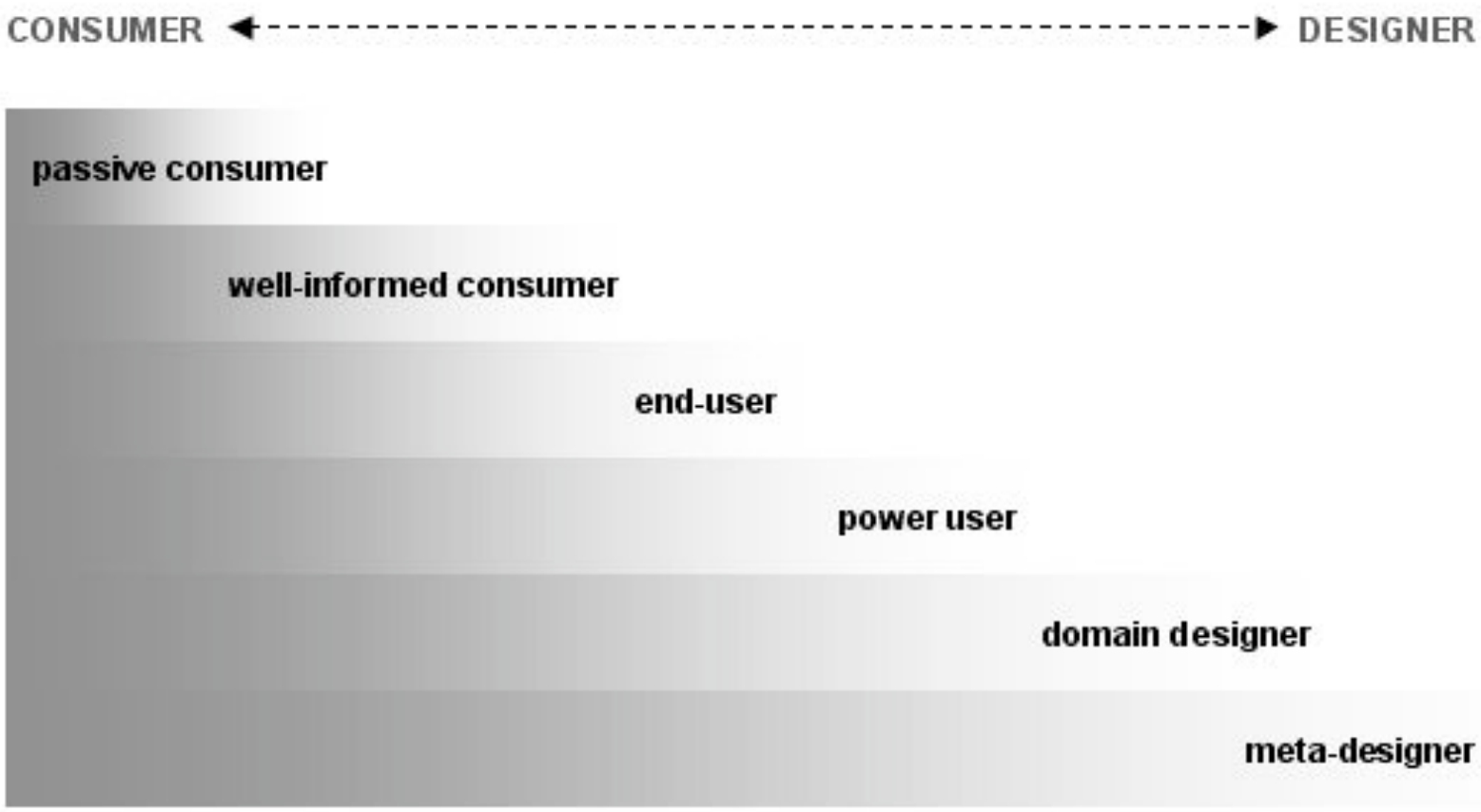
- **user control:**
  - end-user modifiability
  - conviviality (independence of high-tech scribes)
  - ownership (putting owners of problems in charge)

Consumer and Designers — Beyond Binary Choices

- **claims:**
  - there is nothing wrong being a consumer (watching a tennis match, listening to a concert, ...)
  - the same person wants to be a consumer in some situations and in others a designer
  - consumer / designer is not an attribute of a person, but of a context
    consumer / designer ≠ f{person} → f{context}

- **problems:**
  - someone wants to be a designer but is forced to be a consumer → ***personally meaningful activities***
  - someone wants to be a consumer but is forced to be a designer → ***personally irrelevant activities***

Consumer and Designers — Migration Path



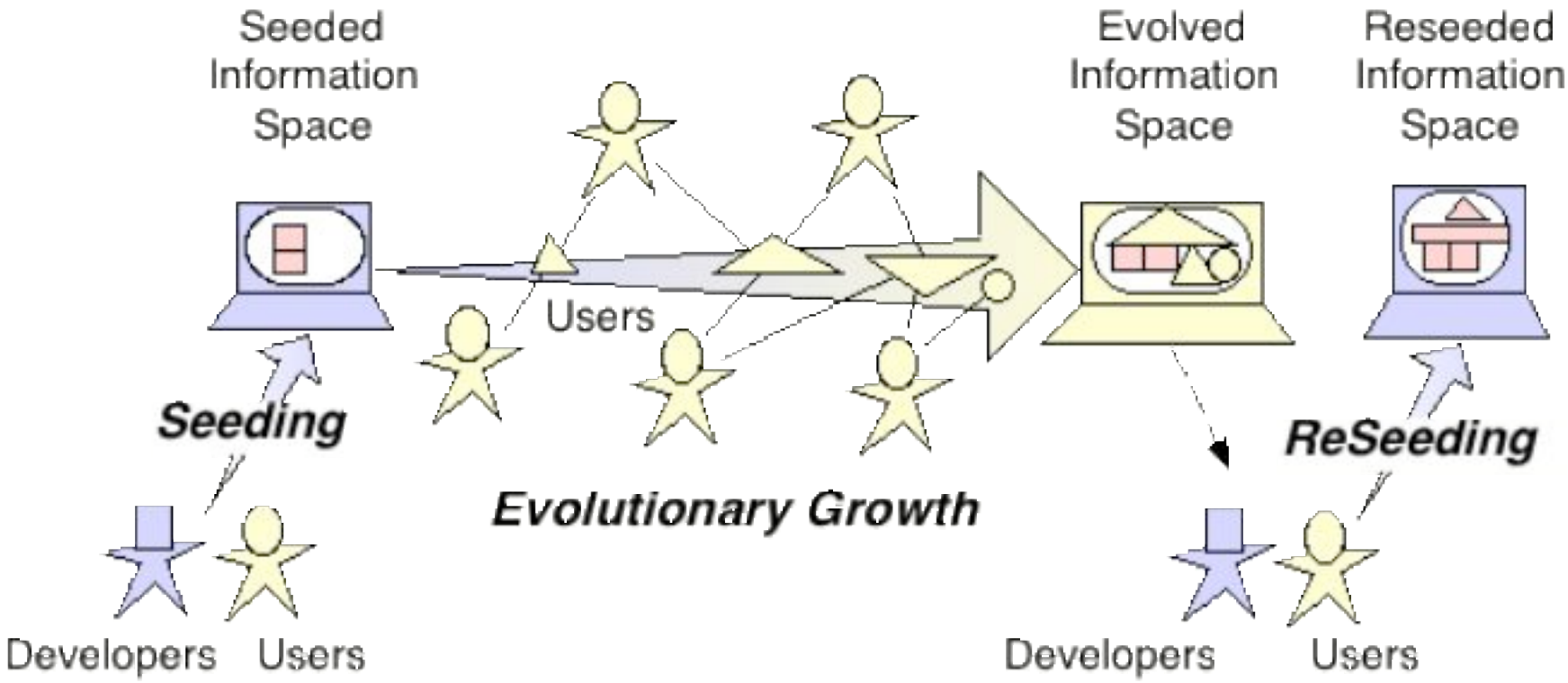
The Seeding, Evolutionary Growth, Reseeding (SER) Model Supporting Meta-Design

- **at design time:**
  - development of an initial system that can change over time (seed)
  - underdesign: creating design options for users

- **at use time:**
  - support for "unself-conscious culture of design": users will experience breakdowns by recognizing "bad fit" at use time
  - end-user modifications allow users to address limitations they experience
  - evolutionary growth through incremental modifications

- **reseeding:**
  - significant reconceptualization of the system
  - account for incremental modifications, mitigate conflicts between changes, and establish an enhanced system

The Seeding, Evolutionary Growth, Reseeding (SER) Model



Comparing Self-conscious and Unself-conscious Cultures of Design

	self-conscious	unself-conscious
definition	an explicit, externalized description of a design exists (theoretical knowledge)	process of slow adaptation and error reduction; situated
original association	professionally-dominated design	primitive societies, handmade things
examples	seeding and reseeding designed cities: Brasilia, Canberra, Abudja	evolutionary growth naturally grown cities: London, Paris
strengths	activities can be delegated; division of labor becomes possible	many small improvements → artifacts well suited to their function; coping with ill-defined, unarticulated problems
weaknesses	many artifacts are ill-suited to the tasks and the users	no general theories exist or can be studied
requirements	externalized descriptions must exist	owner of problems must be involved because they have relevant, unarticulated knowledge

Explore Technical Issues in Real-World Settings
—
Improvisations versus Standardization

- **example:** SAP Info, July 2003, p 33: "Reduce the Number of Customer Modifications"

- **rationale:**

  "every customer modification implies costs because it has to be maintained by the customer. Each time a support package is imported there is a risk that the customer modification may have to be adjusted or re-implemented. To reduce the costs of such on-going maintenance of customer-specific changes, one of the key targets during an upgrade should be to return to the SAP standard wherever this is possible"

- **compare:**
  - "forking" in Open Source
  - "reseeding" in Seeding, Evolutionary Growth, Reseeding Model

Motivational Aspects and Meta-Design

- **what will make humans want to become designers/active contributors over time?**
  - serious working and learning does not have to be unpleasant but can be personally meaningful, empowering, engaging, and fun
  - comment by an artist: *"programming is not hard, but it is boring"*

- **what will make humans want to share?** → requires: mindset change, culture change, community knowledge bases, gift cultures, social capital
  - more details: Fischer, G., Scharff, E., & Ye, Y. (2004) "Fostering Social Creativity by Increasing Social Capital." In M. Huysman, & V. Wulf (Eds.), Social Capital and Information Technology, MIT Press, Cambridge, MA, pp. 355-399.

- **who is the beneficiary and who has to do the work?** → organizational rewards

Utility = Value / Effort

- **increase in value: motivation and rewards for a "design culture"**
  - feeling in control (i.e., independent from "high-tech scribes")
  - being able to solve or contribute to the solution of a problem
  - mastering a tool in greater depth
  - making an ego-satisfying contribution to a group
  - enjoying the feeling of good citizenship to a community ("social capital")

- **decrease in effort:**
  - meta-design is hard
  - extending meta-design to design for design communities

Meta-Design: Transforming Application Areas

- **design:** customization, personalization, tailorability, end-user development, design for diversity — Lieberman, H., Paterno, F., & Wulf, V. (Eds.) (2006) *End User Development - Empowering people to flexibly employ advanced information and communication technology,* Kluwer Publishers, Dordrecht, The Netherlands.

- **architectural design:** underdesign, support for "unself-conscious culture of design" — Brand, S. (1995) How Buildings Learn: What Happens After They're Built, Penguin Books, New York.

- **teaching and learning:** teachers as facilitator, learning communities, courses-as-seeds — dePaula, R., Fischer, G., & Ostwald, J. (2001) "Courses as Seeds: Expectations and Realities," Proceedings of the Second European Conference on Computer-Supported Collaborative Learning (Euro-CSCL' 2001), Maastricht, Netherlands, pp. 494-501.

- **informed participation:** beyond access, social creativity — Arias, E. G., Eden, H., Fischer, G., Gorman, A., & Scharff, E. (1999) "Beyond Access: Informed Participation and Empowerment," Proceedings of the Computer Supported Collaborative Learning (CSCL '99) Conference, Stanford, pp. 20-32.

Meta-Design: Transforming Application Areas — Continued

- **open source:** a success model of decentralized, collaborative, evolutionary development — Scharff, E. (2002) *Open Source Software, a Conceptual Framework for Collaborative Artifact and Knowledge Construction*, Ph.D. Dissertation, University of Colorado at Boulder.

- **living memories / content management systems:** collaboratively constructed content (e.g., Wikipedia) — dePaula, R. (2004) The Construction of Usefulness: How Users and Context Create Meaning with a Social Networking System, Ph.D. Dissertation, University of Colorado at Boulder.

- **digital libraries:** community digital library — Wright, M., Marlino, M., & Sumner, T. (2002) Meta-Design of a Community Digital Library, D-Lib Magazine, Volume 8, Number 5, Available at http://www.dlib.org/dlib/may02/wright/05wright.html.

- **interactive art:** collaboration, co-creation, puts the tools rather than the object of design in the hands of users — Giaccardi, E. (2004) Principles of Metadesign: Processes and Levels of Co-Creation in the New Design Space, Ph.D. Dissertation, CAiiA-STAR, School of Computing, Plymouth, UK.

The Potential Mismatch Problem in Teaching and Learning

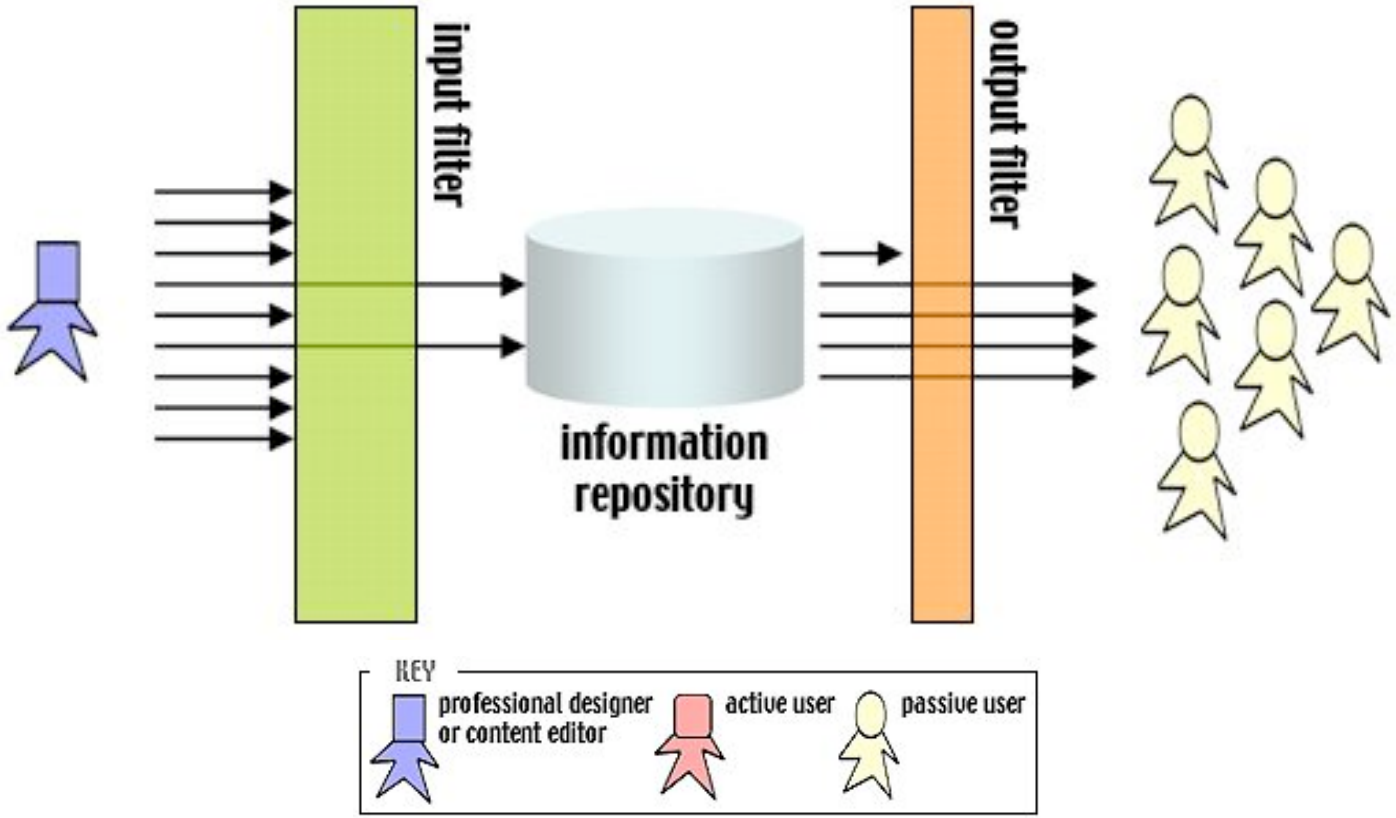
Teacher	Student	Example
authority ("sage on the stage")	dependent, passive	lecture without questions, drill
motivator and facilitator	interested	lecture with questions, guided discussion
delegator	involved	group projects, seminar
coach/critic ("guide on the side")	self-directed, discovery-oriented	self-directed study group, apprenticeship, dissertation

- **major mismatches:**
  - dependent, passive learners take courses with non-directive teachers, and
  - self-directed, discovery-oriented active learners take courses with directive, authoritarian teachers

- **lessons learned:** meta-designers can create **possibilities** for participation and involvement, but they **can not enforce** participation and involvement

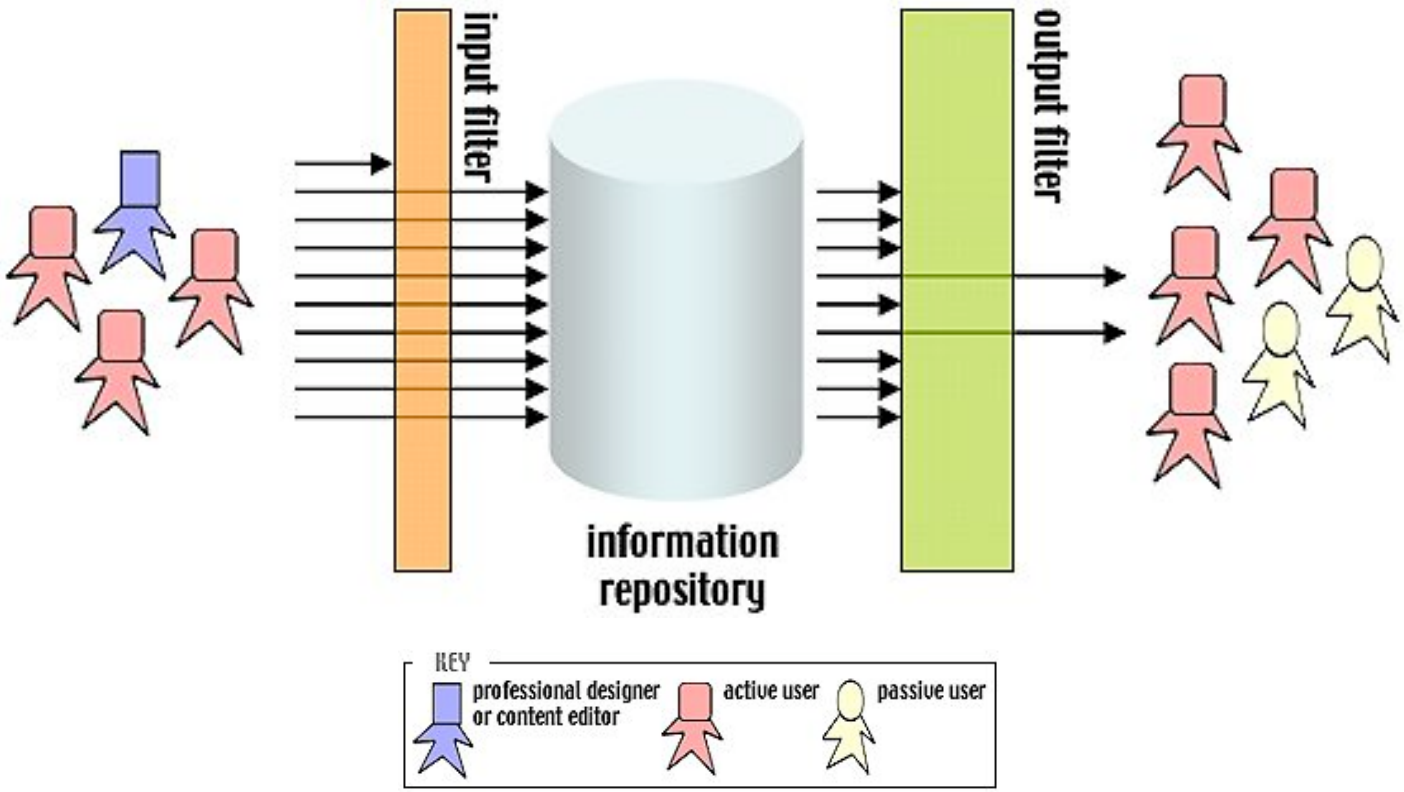
Knowledge Sharing in a Consumer Culture ("Access")

- Strong Input Filters, Small Information Repositories, Weak Output Filters
- Limitation: Making All Voices Heard



Knowledge Sharing in Design Culture ("Informed Participation")

- Weak Input Filters, Large Information Repositories, Strong Output Filters
- Limitation: Trust and Reliability of Information



Trust

- **open source software** versus commercial software
  - "if there are enough eye balls, are bugs are shallow"

- **Wikipedia** versus Encyclopedia Britannica
  - equally applicable: "if there are enough eye balls, are bugs are shallow"

- South Korea's stem cell scandal → the results were published in ***Science*** and ***Nature*** (two of the most carefully reviewed journals)

- Popper's theory about **falsification:**
  - truth content of our theories cannot be verified, but can only be falsified
  - interplay between tentative theories (conjectures) and error elimination (refutation)

Mindsets, Cultures, and Environments for Meta-Design

- how can we **educate and support skilled domain workers?**
  - who are neither novices nor naive users, but
  - who are interested in their work and
  - who see the computer as a means rather than as an end

- how can we create **co-evolutionary environments?**
  - in which users change, because they learn, and
  - in which systems need to be changed, because users become co-developers and engage in end-user modification and programming

Conclusions

- **meta-design offers:**
  - to invent and design a culture in which all participants in collaborative design processes can express themselves and engage in personally meaningful activities

- **meta-design requires**
  - a new **mindset** of all participants
  - designers giving up some **control** at design time
  - **active contributors** and not just passive consumers at use time

- **meta-design raises many issues and research problems of fundamental importance** including
  - new design methodologies
  - a new understanding of cognition, collaboration, and motivation
  - the design of new media and new technologies

Some Publications Relevant to Design and Meta-Design

for a complete list including pdf files to be downloaded:

http://l3d.cs.colorado.edu/~gerhard/papers.html

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